To: Carolyn D'Almedia, RPM

From: Eva Davis

Subject: Draft Addendurm #2, Remedial Design and Remedial Action Work Plan for Operable Unit 2, Revised Groundwater Remedy, Site ST012, Former Williams Air Force Base, Mesa, Arizona

Dear Carolyn,

I have reviewed the Draft Addendurm #2 to the Remedial Design and Remedial Action Work Plan for Operable Unit 2 for the Revised Groundwater Remedy for Site ST012 at the Former Williams Air Force Base in Mesa, Arizona, dated November 30, 2015. The purpose of this Addendum, according to Section 1.1 of the document, is to update information on site conditions including mass characterization, present the design for enhanced bioremediation (EBR) implementation, and to describe the planned construction, implementation, and monitoring of the EBR phase of the remedial action. According to Section 6.1 of the Addendum, the purpose of EBR is "to achieve conditions . . .. at ST012 such that contaminants will degrade by natural attenuation to achieve the cleanup levels within the projected remedial timeframe (i.e., about 20 years) after completion of EBR." While the conditions needed for natural attenuation to be successful in 20 years are not defined here, Amec has previously stated that benzene concentrations of 100 to 500 μg/L can be degraded by natural attenuation to achieve the ROD cleanup goals within the remedial timeframe. The Addendum does not demonstrate that the planned EBR can meet the goals of achieving conditions that would allow natural attenuation to reach soil cleanup criteria in the remedial timeframe.

By my recollection, the initial concept brought to EPA by the Air Force and AMEC was that Steam Enhanced Extraction (SEE) would be used to treat the light non-aqueous phase (LNAPL) beneath the water table at ST012, and EBR would be used to treat dissolved phase contamination outside of the thermal treatment area. As wells were installed for the SEE system, soil cores were collected to further characterize the distribution of LNAPL in the subsurface, and LNAPL contamination was found in areas that were expected to be free of LNAPL. This lead to an expansion of the SEE system to the extent possible in the lower saturated zone (LSZ), until the system ran up against Sossaman Road and other surrounding land uses that are not compatible with SEE. Although significant LNAPL was found outside of the planned treatment area in the cobble zone (CZ) and upper water bearing zone (UWBZ), above where SEE was to be used in the LSZ, the thermal treatment area in the CZ and UWBZ were not increased to include these areas, leaving considerable LNAPL in accessible areas that was not addressed by SEE. If the mass estimates in the Addendum are anywhere near correct, AMEC is now proposing to treat a greater amount of LNAPL mass using EBR then was treated using SEE. This is not what I had understood to be the original remedial concept for ST012, and I think it raises serious questions about the ability of the proposed remedies to meet the ROD-stated remedial goals within the remedial timeframe.

Additional comments on the changes to EBR in the Addendum from previously-approved documents, the lack of characterization of the remaining LNAPL mass extent, and

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General Comments

1.In theory it would appear that the Addendum is an update of Section 3.5 of the Final Remedial Design/Remedial Action Work Plan (RD/RAWP), dated May 2014. Comparing Section 3.5 of the Final RD/RAWP to Addendum #2, it appears that AMEC is scaling back their prior plans for active EBR. The estimate of LNAPL mass in the subsurface has been reduced from a range of 5.8 - 10.4 million pounds, to a range of 4.6 - 10.2 million pounds, but the expected sulfate usage has been reduced from 7,600 tons to 838 tons. The total number of injection and extraction wells has been reduced from 60 to 50, including reducing the number of injection and extraction wells in the UWBZ (where the Addendum says approximately one half of the remaining mass is) by 2 and 9, respectively; and the distribution of terminal electron acceptor (TEA) in the areas outside of the thermal treatment zone believed to be contaminated by LNAPL has been significantly reduced (compare Figures 3-4, 3-5, and 3-6 of the Final RD/RAWP to Figures E-1, E-2, and E-3 of Addendum #2). In addition, the operation of a recirculation system, which had been expected to operate for 1.5 to 3 years during EBR, was reduced to 'dosing using batch injections coupled with groundwater extraction . . . will operate until satisfactory TEA distribution is achieved" and recirculation will be employed only "if necessary".

None of these changes from the approved Final RD/RAWP are explained in the Addendum, none of them would appear to be justified based on the small decrease in the modeled area believed to contain LNAPL, and all of them – especially when taken together - would appear to severely reduce the amount of enhancement to natural biodegradation that is being planned.

2.Addendum #2 presents a confusing array of estimates of LNAPL mass in the subsurface, both pre-SEE (Table 2-1) and post-SEE (Table 2-6 and Table 2-7). According to Section 2.1, pre-SEE LNAPL contours were developed for the site based on Pre-Design Investigation data, historical borings, and where LNAPL had been observed in monitoring wells, which were imported into a three dimensional model which interpolated a surface between the contours. Interpolated contours from a three dimensional model should not be substituted for actual field characterization of the extent of LNAPL in the soil and dissolved in the groundwater. This characterization must be completed before finalizing plans for the EBR, to ensure that all areas of remaining contamination are treated.

3.The design of the EBR system in Addendum #2 is only conceptual in nature. A complete design must include, at a minimum, the following information:

- TEA injection rates, time for injections to occur, injection/extraction ratios, predicted travel time of sulfate to extraction points, criteria to convert to recirculation system if desired TEA distribution is not achieved
- Wier tank to be used, size; design of particle filtration and granular activated carbon systems, controls/interlocks of these systems
- Which injection wells will receive TEA solution via direct pumping, which require portable mixing tanks, size of mixing tank

Specific Comments – Comparsion to Final RD/RAWP

4.The Final RD/RAWP, dated May 2014, on page 3-12, states that single well injection-withdraw tests will be conducted in each hydrostratigraphic zone to assess TEA selection and

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delivery. However, the Addendum states that only wells in the LSZ were used for pilot testing of sulfate injection and determination of utilization rates. BEM (BEM, 2011, Final Phase 1 Thermal Enhanced Extraction (TEE) Pilot Test Performance Evaluation Report, prepared for Air Force Center for Engineering and the Environment, Lackland AFB, Texas, March 2011) in Appendix M states that biodegradation rates are higher in the LSZ than in the UWBZ. Thus, the utilization rate found in the LSZ during the pilot scale may overestimate biodegradation rates in the UWBZ.

5.The Final RD/RAWP, dated May 2014, on page 3-13, states that the top of the well screen section for each UWBZ injection well will be set 20 feet below the top of the CZ/UWBZ interface because particle tracking analysis had concluded that when liquids were injected into the entire depth of the UWBZ, a large portion of the liquid traveled rapidly into the CZ due to its high conductivity. The CZ/UWBZ interface is at approximately 161 feet below ground surface, thus UWBZ injection well screens should be at 181 feet and deeper. However, Table 4-1 shows that UWBZ injection well screens will start at 170 feet bgs.

6.The Final RD/RAWP, dated May 2014, in Table 3-6, shows a total extraction rate of 160 gpm, with a ratio of extraction to injection of 1.4. Addendum #2 states that the extraction rate is expected to be approximately 100 gpm, however, no injection rate is given. What is the reason for the decrease in extraction rate? Will the ratio of extraction to injection be maintained at 1.4?

7.The Final RD/RAWP, dated May 2014, states in Table 3-8 that one of the advantages of sulfate as a terminal electron acceptor is, "The utilization factor for sulfate and JP-4 is estimated at approximately 5 pounds of sulfate per pound of JP-4 degraded. Therefore, based on the estimated volume of LNAPL to be treated outside the TTZ, approximately 7,600 tons of sulfate are required." What is the basis for the utilization factor for sulfate and JP-4 given here? What is the basis for reducing the planned sulfate usage to 838 tons, as given in the Addendum?

8.The Final RD/RAWP, dated May 2014, states in Table 3-8 that one of the disadvantages of sulfate as a terminal electron acceptor is, "sulfate reduction of petroleum hydrocarbons can produce hydrogen sulfide gas. However, the relatively deep vadose zone and site hydrogeology along with careful attention to dosing mass and distribution can limit the potential for hydrogen sulfide gas accumulation at unsafe levels." How will the dosing mass and distribution be monitored and controlled to limit the potential for hydrogen gas to accumulate at unsafe levels?

9.The Final RD/RAWP, dated May 2014, in Table 3-8, states that sulfate is a secondary groundwater contaminant. Figures E-1 and E-3 show that some of the injected sulfate is expected to migrate downgradient from the existing plume. What are the expected downgradient concentrations of sulfate, and do these concentrations exceed the standards for sulfate?

10.The Final RD/RAWP, dated May 2014, on page 3-17, states that the required mass of sulfate could be added to the CZ, UWBZ, and LSZ over a 30-day period of recirculation, utilizing a stock solution at 20 percent of the solubility limit of sulfate. Once the sulfate is added, the "system recirculation would be operated to distribute the sulfate throughout the treatment area. Sulfate distribution in the UWBZ and LSZ would be accomplished be recirculating the system for approximately 1.5 to 3 years." The Addendum states that the sulfate will be injected at a concentration near its solubility limit, but does not discuss the length of time required to inject it.

11.The Final RD/RAWP, dated May 2014, on page 3-18, states that the overall system will be hydraulically designed to capture and maintain the plume geometry. However, the modeled TEA injection pathlines shown in Figure E-1 for the CZ and E-3 for the LSZ do not show that the plume – or the injected sulfate – will be captured by the extraction well system.

12. The Final RD/RAWP, dated May 2014, included recirculation of the injected TEA. Addendum #2 includes recirculation only 'if necessary' (Section 3.2.3). What is the basis for this change in approach? What performance monitoring data would indicate that a recirculation system is necessary?

13. The Final RD/RAWP, dated May 2014, on page 3-18 states that hydraulic capture will be evaluated during EBR. However, monitoring for hydraulic capture does not appear to be included in the Addendum in Table 5-1.

Specific Comments on Addendum #2

14. Section 2.1 states that the PDI LNAPL total residual volume estimates ranged from 5,600,000 to 10,400,000 pounds. Table 2-6 and 2-7 show 1,914,704 to 2,012,020 pounds of LNAPL removed during SEE treatment, with 58,519 to 86,966 pounds of that being benzene, toluene, ethylbenzene, xylene, and naphthalene (BTEX+N). According to Table 2-5, on average 9.85 percent of the LNAPL is BTEX+N, thus the remaining LNAPL, based on the BTEX+N estimates given in these tables, would be 594,101 to 882,904 pounds. This is not in agreement with remaining mass calculations based on the residual estimates given in Section 2.1 based on the PDI, and the removal estimates provided in Tables 2-6 and 2-7, which would lead to a remaining LNAPL mass of 3,588,000 to 8,485,296 pounds. The BTEX+N remaining mass given in Tables 2-6 and 2-7 are also not in agreement with the estimates provided in Section 2.3 of up to 987,000 pounds of BTEX+N.

15.Section 2.1 of Addendum #2 states, "it is expected that mobile LNAPL will be removed via mechanical extraction from wells during both the remainder of SEE operations and EBR system implementation." NAPL extraction under ambient conditions is not efficient, all mobile NAPL will not generally migrate to extraction wells. Where NAPL extraction has been used as a remedial technology, much closer well spacing is generally used, on the order of 20 feet. It should not be assumed that all mobile NAPL will be mechanically removed by the system described in this Addendum.

16.Addendum #2 on page 2-4 states that the 18,000 to 25,000 pounds of BTEX+N in the LPZ will not be targeted directly with EBR. How will this affect the ability of this remediation to achieve the remedial goals?

17.Addendum #2 on page 3-5 states that. "The calculations for the distribution of TEA amongst injection wells used the lower bound of the estimated remaining mass at ST012". What is the planned dosage of sulfate per pound of JP-4 to be degraded? Does this approach, of using the lower bound of the mass estimate to calculate the dosage when there is so much uncertainty in the amount of mass present, set this process up for failure?

18.Section 3.2.2 states that "Additional well locations may be added based on information collected in the field". Please describe what information is to be collected in the field, and what information would lead to adding well locations.

19.Section 3.3 states that arsenic levels will be monitored after EBR implementation to confirm arsenic levels are returning to background conditions. What will be done if arsenic concentrations do not decline after the completion of EBR?

20.Section 5.0 states that process monitoring will include microbial activity. However, microbial activity sampling is not included in Table 5-1.

21.Table 5-1 of the Addendum lists wells C02, U02, W12, U37, RB-3A, W24, U38, W38, U12 as monitoring wells for monitoring the performance of EBR. The locations of these wells are not shown on Figure 3-1. The monitoring wells that are shown in Figure 3-1 are not consistent with Table 5-1. To evaluate the adequacy of the proposed monitoring well network, a figure should be provided showing the extent of contamination in each of the three zones, the injection and extraction wells, the modeled TEA injection pathlines, and the proposed monitoring wells. Monitoring wells should be within and/or just downgradient of the LNAPL areas that are to be treated using EBR. Table 5-1 and this figure must be consistent.

22.According to Section 6.1 of the Addendum, the purpose of EBR is "to achieve conditions . . .. at ST012 such that contaminants will degrade by natural attenuation to achieve the cleanup levels within the projected remedial timeframe (i.e., about 20 years) after completion of EBR." Nothing in the Addendum demonstrates that this planned approach for EBR is capable of achieving this goal.

23.Figures E-1, E-2, and E-3 of Addendum #2 show the modeled TEA injection pathlines in the CZ, UWBZ, and LSZ, respectively. The projected pathlines clearly show that the entire LNAPL extent (outside of the thermal treatment zone) in each of these zones will not receive TEA. It is not clear how the proposed distribution of injection and extraction wells can be considered adequate based on the modeled LNAPL extents.

If you would like to discuss any of these comments, I would be happy to do so. I can be reached at (580) 436-8548 or davis.eva@epa.gov.